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Electrical Resistivity Modeling of a Permeable Reactive Barrier for Vista Engineering Technologies: Summary

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We have performed a numerical modeling study that evaluated the capacity of electrical resistance tomography (ERT) to detect flaws in a passive reactive barrier (PRB). The model barrier is based on a real barrier described in the literature Slater and Binley (2003). It consists of highly conducting, granular iron emplaced within a trench. We assumed that the barrier was filled with a mixture of iron and sand, and that vertical electrode arrays were embedded within the barrier.

We have considered a) characterization and b) monitoring scenarios. For (a), the objective is to use tomographs of absolute resistivity to detect construction flaws and inhomogeneities in iron distribution shortly after installation. For (b), the objective is to use resistivity change tomographs to detect iron oxidation and barrier plugging as a function of time.

The study considered varying PRB hole sizes and locations. For any given model, a hole was located right next to and near the center of an electrode array (maximum sensitivity and resolution expected), at the center between two electrode arrays (moderate sensitivity and resolution), or near the bottom centered between the two arrays (minimum sensitivity and resolution). We also considered various hole sizes. The smallest hole considered had a height and a width of 0.33 m (0.11 m^2), or 1/2 of the electrode spacing within an array; the depth of the hole was always equal to the thickness of the barrier (0.66m). The largest hole had a height and a width of 1.22 m (1.74 m^2). We also modeled a medium sized hole with a height and a width of 0.66 m (0.44 m^2). The PRB material had an electrical resistivity of 0.3 ohm-m (sand/iron mix) while the hole's resistivity was 3.0 ohm-m.

The study also considered various array aspect ratios because it is well known that aspect ratio controls sensitivity and resolution when line arrays of electrodes are used (Ramirez et al., 1993). Aspect ratio is defined as the distance between the top and bottom electrodes in an array divided by the distance between adjacent arrays. Previous work suggests that an aspect ratio of 2:1 is a good compromise that offers good sensitivity/resolution while minimizing the need for closely spaced boreholes. In this study we have considered aspect ratios of 2:1 (best resolution, closest borehole spacing), 1.5:1, and 1:1 (worst resolution, longest borehole spacing).

The study suggests that in a monitoring scenario, when an aspect ratio of 2:1 is used, flaws as small as 0.11m^2 (0.33 m on a side) can be detected for most flaw locations. When the aspect ratio changes to 1.3:1, the smallest flaw detectable at all flaw positions is 1.74 m^2 (1.32 m on a side). A 1:1 aspect ratio yields fairly poor results, only resolving flaws that are very close to an electrode array.

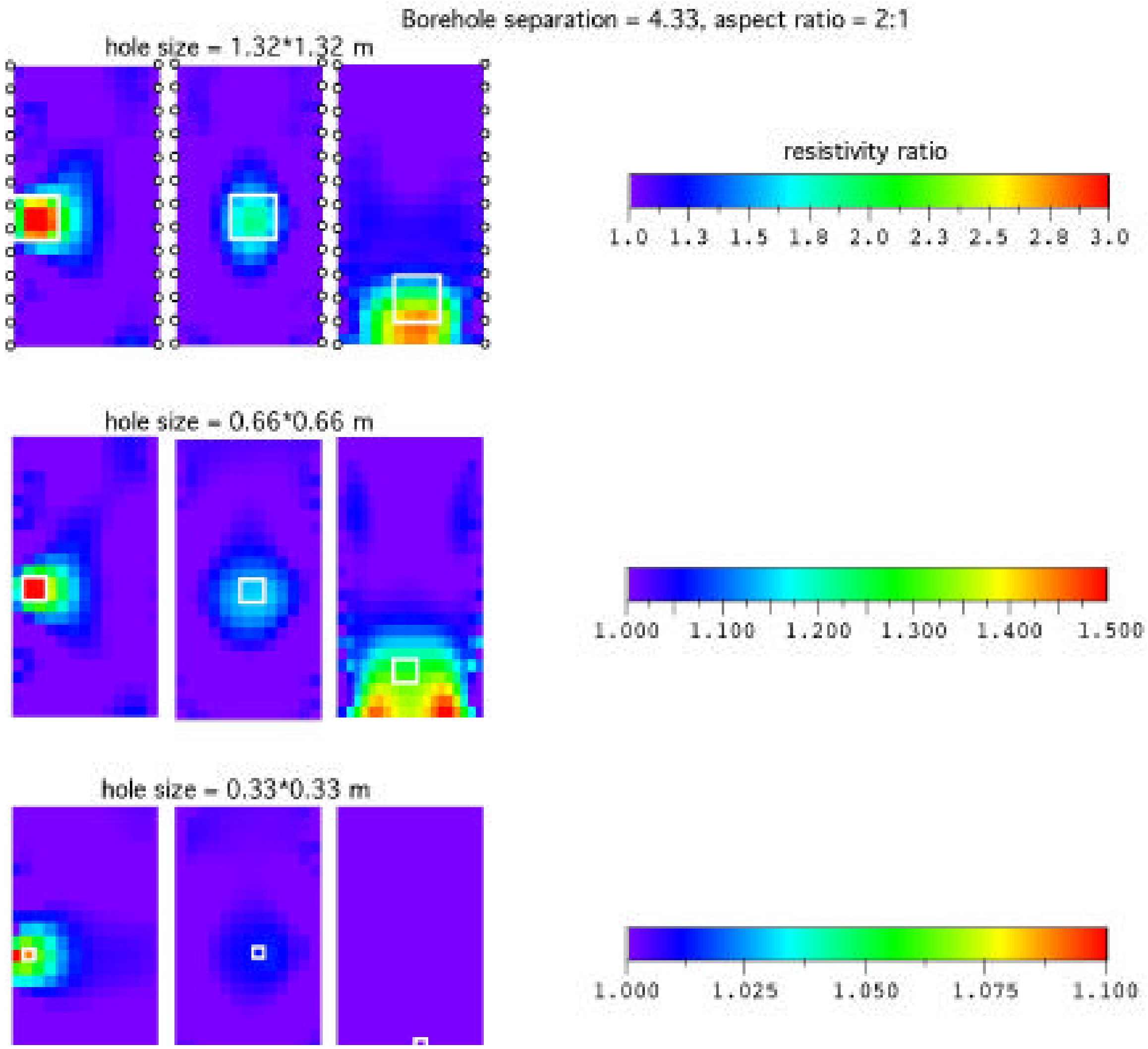

Figure 1 shows the results obtained for a monitoring scenario. Various hole sizes and positions are shown (the hole position is indicated by the white square superimposed on the images). The black and white circles on the sides of the images represent the electrodes. The hole size in the model decreases along a given column of images from top to bottom. Each row of images is rendered using a different color bar. The aspect ratio is 2:1 which should offer the best resolution and sensitivity of all.

References:

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Slater, L. and A. Binley, 2003, Evaluation of permeable reactive barrier (PRB) integrity using electrical imaging methods, *Geophysics*, vol. 68, no. 3 (MAY-JUNE 2003), p. 911–921.

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